Attachment A

Proposed Addition to Section 15.211 of the Commission's Rules:

Subsection (e):

"The use of GPS re-radiation devices, as part of a tunnel radio system or otherwise limited to indoor usage, with equipment certified in accordance with the provisions of Section 15.201, shall be permitted provided that the re-radiation system is in compliance with the provisions of Section 15.211 (c)).

Attachment B

Proposed Language for a regulatory change should the Commission determine that Section 15.211 is not appropriate. This language could be used in a new rule section or appended to such other rule section as the Commission deems appropriate.

"The use of a GPS re-radiation device, using a kit properly certificated in accordance with Part 2 of the Commission's Rules and in accordance with Section 15.201, shall be permitted only if such kit is used indoors or underground, with no signal perceptible outside of a building at a distance greater than two meters from any door or window."

Exhibit A
Air Force Report on GPS Networking Re-Radiation Kits

Exhibit B

Met Laboratories Report on GPS Networking Re-radiation Kits

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE FLIGHT TEST CENTER (AFMC)
EDWARDS AIR FORCE BASE, CALIFORNIA

MEMORANDUM FOR LOCKHEED MARTIN
Attn: Mr. Bruce Fox

24 Sept, 2003

FROM: AFFTC/ITCFS
Building P300 (South Base)
Edwards AFB CA 93524

SUBJECT: GPS Hood System at Plant 42, Palmdale, CA.

Re: Experimental usage in accordance with Ch 7 of the NTIA manual Ref paragraph 7.11, Authorization letter.

1) This authorization does not constitute a bar to other activities use of U-2 GPS Hood Test, Plant 42 reradiating hood system. it is only an authorization for U-2, Plant 42 program use. If harmful interference is received on any frequency, contact this office immediately and we will isolate and resolve the interference. Do not attempt to resolve interference issues without AFFTC Spectrum Management involvement. AFFTC Spectrum Management will mitigate any interference issue to insure that all involved parties can complete mission goals with minimal impact to their respective program schedules.

2) The request was made to have the Spectrum Management's personnel and their test equipment, perform a series of RF leakage tests on the GPS reradiating hood system. This test was performed and conducted on 26 August 2003. As listed, test equipment used to conduct and perform this test:

a) Hewlett Packard 8563-A spectrum analyzer.
b) HP11941-A close –field test probe.
c) Sucoflex 104E low lose feed line.

3) Use of U-2 GPS reradiating hood system in its frequencies range is on a Non Interference Basis (NIB). If any other authorized user receives interference, operation of this system will be terminated until Spectrum Management can investigate and determine the cause of the interference.

4) An emergency POC will be established for immediate shutdown and identified to AFFTC Frequency Management (661) 277-8880 (DSN 527-8880) NLT 1 OCT 03

5) Thank you for your assistance on this most delicate matter. Point of Contact for this letter is Casey Taylor, 7-4763.

CASEY TAYLOR, CIV, DAF
Chief, Spectrum Management
Spectrum Management Office

MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

Electromagnetic Compatibility Test Report

for the

GPS Networking
Re-Radiator

MET Report: EMC13435

June 10, 2003

Prepared For:

GPS Networking
710 A West 4th Street
Pueblo, CO 81003

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave., Baltimore, MD 21230

Electromagnetic Compatibility
Test Report

for the
GPS Networking
Re-Radiator

Testing Performed By:

Liming Xu
Test Engineer

Report Prepared By:

Christina M. Karlhoff
Documentation Department

L. Leonard Knight
EMC Lab Manager

Report Status Sheet

Revision	Report Date	Reason for Revision
1	June 10, 2003	*Initial Issue.*

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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
d	Measurement Distance
dB	Decibels
dBμV/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
EUT	Equipment Under Test
f	Frequency
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
MHz	Megahertz
RF	Radio Frequency
V/m	Volts per meter

I. Introduction

A. Definition of Test Sample

GPS Networking's re-radiation kits allow the indoor reception of GPS signals where the satellite signals cannot reach, such as inside a test lab or inside an aircraft hangar. The kits re-radiate the satellite generated information on either of the L-1 and L-2 frequencies, 1575.42 MHz and 1227.6 MHz respectively, or just the L-1 frequency. Each kit consists of a rooftop receive antenna, a length of low-loss RF cable, a line amplifier – to replace signal strength that is lost in the cable – and a passive GPS antenna which re-radiates the signal indoors.

B. Purpose of Test

An EMC evaluation was performed to determine the potential interference sphere of a re-radiation kit, and to establish how, when, and where use of re-radiation kits can be conducted safely. The testing is intended to provide guidance for future real-world applications in military, government and aerospace environments or other public safety and laboratory applications.

These tests were conducted on a sample of the equipment for the purpose of demonstrating the impact of a re-radiation kit in various scenarios. Conclusions drawn regarding potential for interference or non-interference were made based upon the reactions of two handheld GPS receivers.

The results of the tests will be presented to federal frequency regulators and interagency frequency coordinators for evaluation in establishing a regulatory structure for the proper use of re-radiation kits.

II. Equipment Configuration

A. References

ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories

Table 1. References

B. Test Site

All testing was performed at MET Laboratories, Inc., Baltimore, MD. All equipment supplied by MET, used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

C. Description of Test Sample

A re-radiation kit consists of a GPS receiving antenna (placed outside, in sight of the sky) connected to low-loss rf cable, which leads to a line amplifier, which is then connected to a passive GPS antenna (EUT) that "re-radiates" the GPS signal received outside.

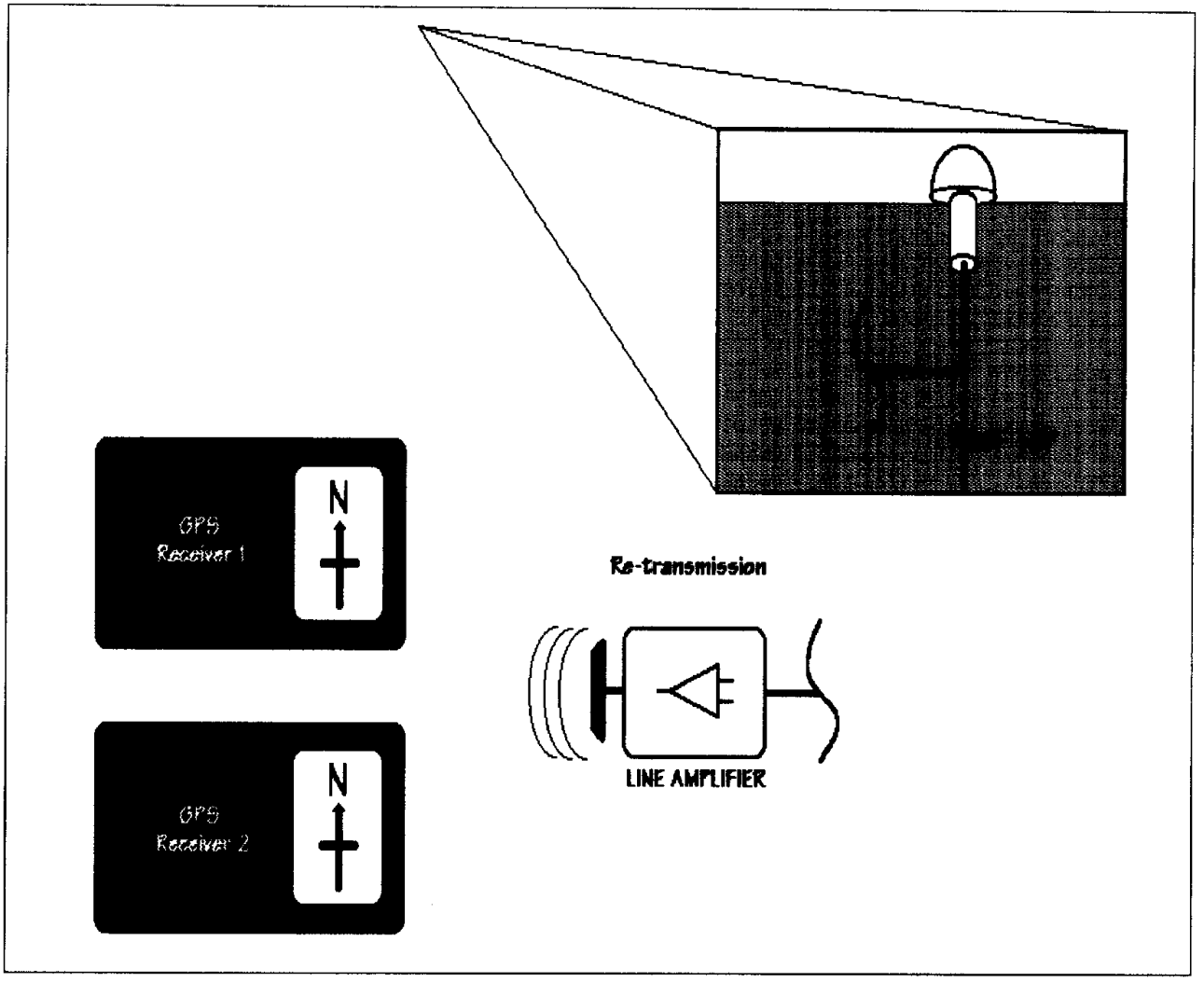

Figure 1. Block Diagram Identifying Test Sample

D. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup.

Name / Description	Model Number	Serial Number
Re-Radiator Antenna	GPS-P2	101805
GPS Line Amplifier	None Listed	8160
ACC GPS Receiving Antenna	GPS – (SB2)	101036
Handheld GPS Receiver #1	GPS 45	34700084
Handheld GPS Receiver #2	GPS 12XL	92227708
Low Loss Hi-Frequency Cable	LMR-600	None Listed
Low Loss Hi-Frequency Cable	RG214-U	None Listed

Table 2. Equipment Configuration

E. Mode of Operation

A rooftop GPS receive antenna was mounted to the roof receiving a GPS signal. The signal from the active rooftop GPS antenna was cabled to a line amplifier, which drove a GPS re-radiator.

F. Method of Monitoring EUT Operation

When a GPS signal is received, the receiver establishes a position and its reading is displayed, steady and constant. An indication that the EUT is not functioning in a manner intended by the manufacturer would be when two signals would be perceived, and the receiver would fluctuate in its position and not display a steady and constant position.

G. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to GPS Networking upon completion of testing.

III. Electromagnetic Compatibility Evaluation

Electromagnetic Compatibility Evaluation

Test # 1

Test Purpose:

The purpose of this test was to determine the effects (measured in relative attenuation) common building materials would have on the signal strength of the EUT. The testing is essentially pragmatic in nature, intended to provide guidance for future real-world applications.

Test Procedure:

A GPS receiving antenna was mounted on the roof of the laboratory. The antenna was then connected to the bulkhead of the Semi-Anechoic Chamber via (1) LMR-600 high frequency low loss cable. Inside the chamber, (1) RG214-U cable was then connected from the bulkhead to the EUT. At this point the EUT was energized and a hand held GPS receiver (#1) was used to functionally verify correct operation and position of the EUT.

The EUT was then placed 1 m. from a receiving horn antenna. The horn antenna was then connected to a high frequency spectrum analyzer. Signal strength measurements (@ 1575.42 MHz) were taken with the EUT being rotated on its X/Y axis to determine the location of the maximum signal strength (major lobe). All testing was then performed with the EUT in this "maximized" position. The set-up for this test is shown in Figure 2.

Electromagnetic Compatibility Evaluation

Test # 1

Test Procedure (Continued):

Next, the maximized signal strength measurement was recorded. This was used as a baseline measurement for later comparison. Each of the following materials were then placed equal distance between the EUT and receiving horn antenna:

1. 3/8" Wallboard
2. Styrofoam Panel
3. 5/8" Plywood
4. Particle board with double-sided sheet metal
5. Copper sheet metal
6. Cement Block – damp
7. Cinderblock – dry
8. Cellotex – foil faced polyisocyanurate
9. Ceiling Tile
10. Pane of glass

While each material was placed in between the EUT and receiving horn antenna, the high frequency spectrum analyzer was used to record the individual signal strength measurements. These measurements when compared with the baseline measurement were used to determine the attenuation of each material, and subsequently the effect each common-building material has on the attenuation of the EUT's signal strength.

Electromagnetic Compatibility Evaluation

Test # 1

Test Results: The following baseline measurement was recorded at the beginning of testing:

Amplitude: **72.5 dBuV**
Frequency: **1575.42 MHz**
Distance (from EUT to receiving horn antenna): 1 meter

Material being tested	Position of Material (vertical or horizontal)	Amplitude measured (dBuV)	Deviation from baseline measurement (dB)
3/8" Wallboard	H	70.3	-2.2
3/8" Wallboard	V	72.2	-0.3
Styrofoam Panel	H	72.4	-0.1
Styrofoam Panel	V	72.5	0
5/8" Plywood	H	68.9	-3.6
5/8" Plywood	V	70.8	-1.7
Particle board with double-sided sheet metal	H	51.1	-21.4
Particle board with double-sided sheet metal	V	65.3	-7.2
Copper Sheet Metal	V	50.4	-22.1
Cement Block – damp	H	66.3	-6.2
Cinderblock – dry	H	66.8	-5.7
Celotex – foil faced polyisocyanurate board (foil facing EUT)	H	47.6	-24.9
Celotex – foil faced polyisocyanurate board (foil facing EUT)	V	47.5	-25.0
Cellotex – foil faced polyisocyanurate board (foil facing away from the EUT)	V	45.6	-26.9
Ceiling Tile	H	71.1	-1.4
Pane of Glass	H	71.4	-1.1

The following measurement was recorded immediately following the last test:

Amplitude: **71.1 dBuV**
Frequency: **1575.42 MHz**
Distance (from EUT to receiving horn antenna): 1 meter

Electromagnetic Compatibility Evaluation

Test # 1

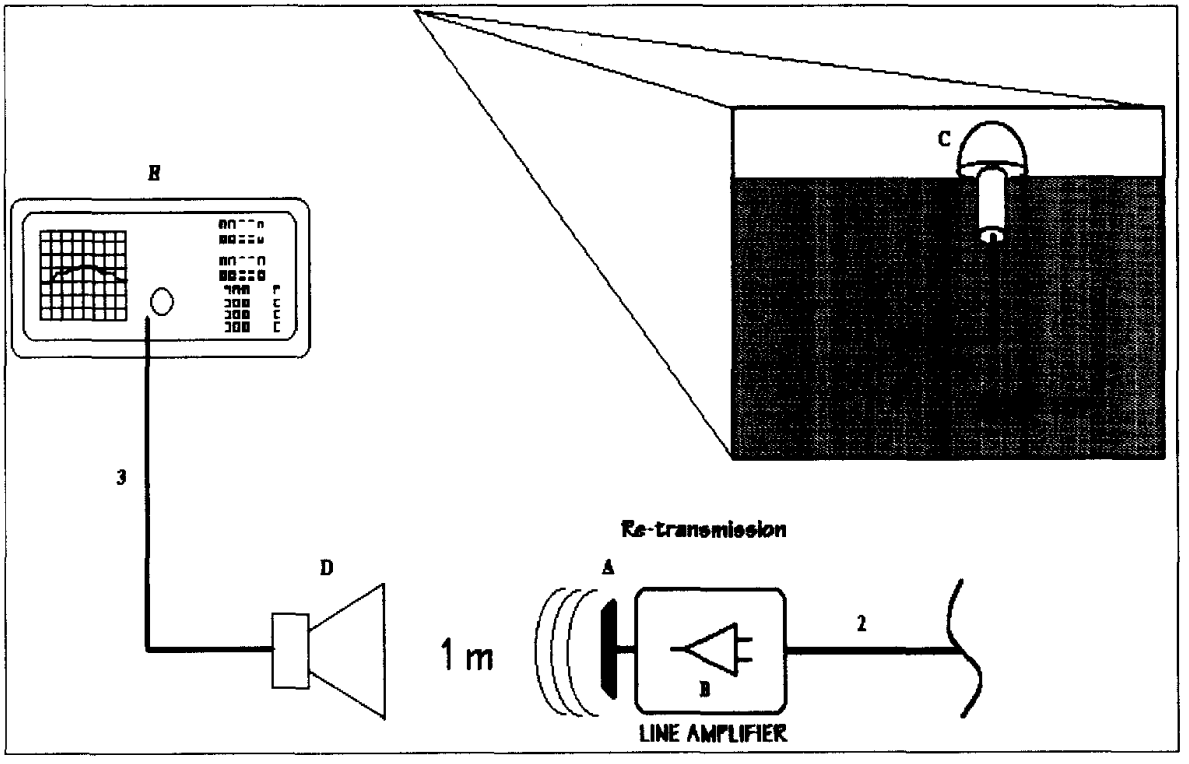

Figure 2. Block Diagram of Test Setup (Test #1)

Electromagnetic Compatibility Evaluation

Test # 1

Equipment Configuration: The EUT was set up as outlined in Figure 2. Block Diagram of Test Setup (Test #1).

Ref. ID	Name / Description	Model Number	Serial Number
A	Re-Radiator Antenna	GPS-P2	101805
B	GPS Line Amplifier	None Listed	8160
C	ACC GPS Receiving Antenna	GPS – (SB2)	101036
D	Receiving Horn Antenna	3115	2543
E	High Frequency Spectrum Analyzer	8563A	3207A01552

Ref. ID	Description	Cable Type
1	Low Loss Hi-Frequency Cable	LMR-600
2	Low Loss Hi-Frequency Cable	RG214-U
3	Low Loss Hi-Frequency Cable	LMR-400FR

Table 3. Equipment Configuration (Test #1)

Electromagnetic Compatibility Evaluation

Test # 2

Test Purpose: The purpose of this test was to determine where and how far the EUT is able to re-radiate the original GPS signal while being located inside a simulated airplane hangar. Using a handheld GPS receiver, measurements were taken outside of the "hangar" at various locations and under different conditions (direct line of sight with open/closed garage doors). These measurements were then used to determine if either the original re-radiated GPS signal was being received or if the primary signal from the GPS satellites were being received.

Test Procedure: A GPS receiving antenna was mounted on the roof of the laboratory. Two handheld GPS receivers were used to verify and record the geographic coordinates of the GPS receiving antenna. The EUT was located in the loading bay on the eastside of the MET Laboratories building (see Figure 3.) The GPS receiving antenna was then connected to the EUT using 160' of high frequency low loss cable.

The EUT was placed in a position that maximizes the re-radiated signal (position determined from Test #1). Using both GPS handheld receivers, measurements were taken at the EUT's location to verify correct operation of the EUT. The coordinates measured were the same coordinates that were previously measured on the roof (site of GPS receiving antenna).

Five measurements were then taken at various locations that were within direct line of site of the EUT. One measurement was taken that was not within direct line of site of the EUT.

The test conditions are as follows:

1. Garage doors # 1 – 2 (Open)
2. Garage door # 1 (Closed)/Garage door # 2 (Open)
3. Garage doors # 1 – 2 (Closed)
4. Garage door # 1 (Open)/Garage door # 2 (Closed)

The measurements were taken using the same two handheld GPS receivers that were used to first record the geographic position of the GPS receiving antenna.

Electromagnetic Compatibility Evaluation

Test # 2

Test Results: The following are the coordinates of the GPS receiving antenna that were measured using two handheld GPS receivers. The measurements were taken on the rooftop, right next to the GPS receiving antenna.

GPS Handheld Receiver #	Coordinates of Rooftop GPS Receiving Antenna
1	N: 39° 14-755 W: 76° 38-009
2	N: 39° 14-754 W: 76° 38-007

Electromagnetic Compatibility Evaluation

Test # 2

Test Results (Continued):

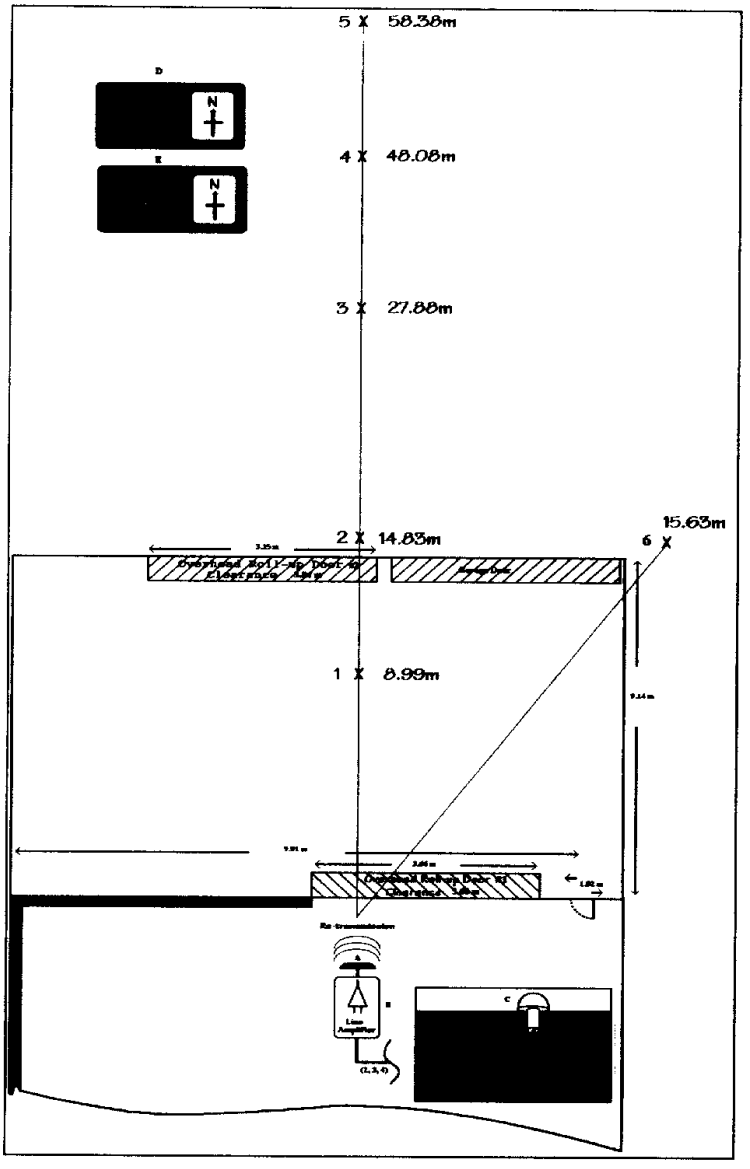

Figure 3. Block Diagram of Test Setup (Test #2)

Electromagnetic Compatibility Evaluation

Test #2

Test Results (Continued): The following are the results that were taken inside/outside of the loading bay (simulated airplane hangar) located on the eastside of the MET Laboratories building. Two handheld GPS receivers were used to make measurements under four different test conditions:

Test Condition #1 (Garage doors # 1 & 2 / Open)

Measurement #	Location	Distance from antenna (meters)	Receiver #1 Coordinates (Lat/Long)	Receiver #2 Coordinates (Lat/Long)	Results (Receiver #1)	Results (Receiver #2)
1	Inside building	8.99	N: 39° 14-757 W: 76° 38-005	N: 39°14-757 W: 76°38-009	GPS re-radiated signal received directly from the EUT	GPS re-radiated signal received directly from the EUT
2	Just outside garage door # 3	14.83	N: 39° 14-752 W: 76° 38-002	N: 39°14-739 W: 76°37-994	GPS re-radiated signal received directly from the EUT	GPS signal received directly from satellites
3	Outside of building	27.88	N: 39°14-727 W: 76°38-019	N: 39°14-740 W: 76°37-997	GPS signal received directly from satellites	GPS signal received directly from satellites
4	Outside of building	48.08	N: 39°14-726 W: 76°37-982	N: 39°14-727 W: 76°37-972	GPS signal received directly from satellites	GPS signal received directly from satellites
5	Outside of building	58.38	N: 39°14-720 W: 76°37-998	N: 39°14-730 W: 76°37-966	GPS signal received directly from satellites	GPS signal received directly from satellites
6	Outside of building – through brick	19.63	N: 39°14-734 W: 76°37-994	N: 39°14-736 W: 76°37-994	GPS signal received directly from satellites	GPS signal received directly from satellites

Test Condition #2 (Garage door # 1 - Closed/Garage door # 2 / Open)

Measurement #	Location	Distance from antenna (meters)	Receiver #1 Coordinates (Lat/Long)	Receiver #2 Coordinates (Lat/Long)	Results (Receiver #1)	Results (Receiver #2)
1	Inside building	8.99	N: 39° 14-757 W: 76° 38-007	N: 39°14-747 W: 76°38-024	GPS re-radiated signal received directly from the EUT	***Fluctuating reading caused by GPS signals received from both the EUT and the satellites.**
2	Just outside garage door # 3	14.83	N: 39° 14-722 W: 76° 37-986	N: 39°14-708 W: 76°37-964	***Fluctuating reading caused by GPS signals received from both the EUT and the satellites.**	***Fluctuating reading caused by GPS signals received from both the EUT and the satellites.**
3	Outside of building	27.88	N: 39°14-731 W: 76°37-985	N: 39°14-732 W: 76°37-977	GPS signal received directly from satellites	GPS signal received directly from satellites
4	Outside of building	48.08	N: 39°14-725 W: 76°37-976	N: 39°14-727 W: 76°37-973	GPS signal received directly from satellites	GPS signal received directly from satellites
5	Outside of building	58.38	N: 39°14-722 W: 76°37-969	N: 39°14-719 W: 76°37-969	GPS signal received directly from satellites	GPS signal received directly from satellites
6	Outside of building – through brick	19.63	N: 39°14-735 W: 76°37-994	N: 39°14-738 W: 76°37-991	GPS signal received directly from satellites	GPS signal received directly from satellites

Note: ***These results show interference between the line of site satellite signals and the EUT. The EUT was located up on a scaffold 2.64m above the garage floor, pointing toward the garage doors (outside of building).**

Electromagnetic Compatibility Evaluation

Test #2

Test Results (Continued):

Test Condition # 3 (Garage doors # 1 & 2 / Closed)

Measurement #	Location	Distance from antenna (meters)	Receiver #1 Coordinates (Lat/Long)	Receiver #2 Coordinates (Lat/Long)	Results (Receiver #1)	Results (Receiver #2)
1	Inside building	8.99	N: 39° 14-756 W: 76° 38-004	N: 39°14-755 W: 76°38-010	GPS re-radiated signal received directly from the EUT	Fluctuating reading caused by GPS signals received from both the EUT and the satellites.
2	Just outside garage door # 3	14.83	N: 39° 14-737 W: 76° 37-986	N: 39°14-737 W: 76°37-972	GPS signal received directly from satellites	GPS signal received directly from satellites
3	Outside of building	27.88	N: 39°14-734 W: 76°37-980	N: 39°14-734 W: 76°37-977	GPS signal received directly from satellites	GPS signal received directly from satellites
4	Outside of building	48.08	N: 39°14-724 W: 76°37-972	N: 39°14-727 W: 76°37-970	GPS signal received directly from satellites	GPS signal received directly from satellites
5	Outside of building	58.38	N: 39°14-722 W: 76°37-968	N: 39°14-720 W: 76°37-967	GPS signal received directly from satellites	GPS signal received directly from satellites
6	Outside of building – through brick	19.63	N: 39°14-734 W: 76°37-993	N: 39°14-735 W: 76°37-990	GPS signal received directly from satellites	GPS signal received directly from satellites

Test Condition #4 (Garage door # 1 - Open/Garage door # 2 / Closed)

Measurement #	Location	Distance from antenna (meters)	Receiver #1 Coordinates (Lat/Long)	Receiver #2 Coordinates (Lat/Long)	Results (Receiver #1)	Results (Receiver #2)
1	Inside building	8.99	N: 39° 14-755 W: 76° 38-008	N: 39°14-752 W: 76°38-009	GPS re-radiated signal received directly from the EUT	GPS re-radiated signal received directly from the EUT
2	Just outside garage door # 3	14.83	N: 39° 14-738 W: 76° 37-991	N: 39°14-864 W: 76°38-136	*Fluctuating reading caused by GPS signals received from both the EUT and the satellites.?	*Fluctuating reading caused by GPS signals received from both the EUT and the satellites.
3	Outside of building	27.88	N: 39°14-726 W: 76°37-989	N: 39°14-732 W: 76°37-982	*Fluctuating reading caused by GPS signals received from both the EUT and the satellites.	GPS signal received directly from satellites
4	Outside of building	48.08	N: 39°14-724 W: 76°37-973	N: 39°14-721 W: 76°37-972	GPS signal received directly from satellites	GPS signal received directly from satellites
5	Outside of building	58.38	N: 39°14-724 W: 76°37-972	N: 39°14-718 W: 76°37-968	GPS signal received directly from satellites	GPS signal received directly from satellites
6	Outside of building – through brick	19.63	N: 39°14-733 W: 76°37-994	N: 39°14-732 W: 76°37-993	GPS signal received directly from satellites	GPS signal received directly from satellites

Note: *The results show interference between the line of site satellite signals and the EUT. The EUT was located up on a scaffold 2.64m above the garage floor, pointing toward the garage doors (outside of building).

Electromagnetic Compatibility Evaluation

Test #2

Test Results (Continued):

The area that is used for shipping and receiving for MET Laboratories, is a space more akin to that of a small aircraft hangar or a space that might have a GPS re-radiation kit installed such as a large garage. We tested with the garage doors open and closed. We also tested from approximately 15 meters to 60 meters beyond the outer garage door (garage door #3).

All readings made were recorded on two hand-held GPS receivers. The accuracy of the GPS receivers that were used had an average accuracy of about 8m. The two GPS receivers demonstrated similar characteristics to each other if they were or were not receiving mixed signals (or interference) from two GPS signals (the direct signal from the satellites and the re-transmitted signals from the EUT). Where there was only one GPS signal received, the receivers would establish a position and their readings would be steady and constant. Where there were two signals perceived, the receivers would fluctuate in their positions and would not give a consistent location.

Electromagnetic Compatibility Evaluation

Test # 2

Equipment Configuration: The EUT was set up as outlined in Figure 3. Block Diagram of Test Setup (Test #2).

Ref. ID	Name / Description	Model Number	Serial Number
A	Re-Radiator Antenna	GPS-P2	101805
B	GPS Line Amplifier	None Listed	8160
C	ACC GPS Receiving Antenna	GPS – (SB2)	101036
D	Handheld GPS Receiver #1	GPS 45	34700084
E	Handheld GPS Receiver #2	GPS 12XL	92227708

Ref. ID	Description	Cable Type
1	Low Loss Hi-Frequency Cable	LMR-600
2	Low Loss Hi-Frequency Cable	LMR-600
3	Low Loss Hi-Frequency Cable	FSJ4-50B
4	Low Loss Hi-Frequency Cable	FSJ4-50

Table 4. Equipment Configuration (Test #2)